REMOTELY RESETTABLE ROPELESS EMERGENCY STOPPING DEVICE FOR AN ELEVATOR

1. Field of the Invention

This invention generally relates to an electrically controlled braking device for an elevator system. More particularly, this invention relates to a ropeless and sheaveless remotely resettable emergency stopping device for an elevator.

2. Description of the Relevant Art

Elevators include a safety system to stop an elevator from traveling at excessive speeds in response to an elevator component breaking or otherwise becoming inoperative. Traditionally, elevator safety systems include a speed sensing device typically referred to as a governor, a governor rope, safeties or clamping mechanisms that are mounted to the elevator car frame for selectively gripping elevator guide rails, and a tension sheave located in an elevator pit. The governor includes a governor sheave located in a machine room, which is positioned above the elevator. The governor rope is attached to travel with the elevator car and makes a complete loop around the governor sheave and the tension sheave.

The governor rope is connected to the safeties through mechanical linkages and lift rods. The safeties include brake pads that are mounted for movement with the governor rope and brake housings that are mounted for movement with the elevator car. If the hoist ropes break or other elevator operational components fail, causing the elevator car to travel at an excessive speed, the governor then releases a clutch that grips the governor rope. Thus, the rope is stopped from moving while the elevator car continues to move downwardly. The brake pads, which are connected to the rope, move upwardly while the brake housings move downwardly with the elevator car. The brake housings are wedge shaped, such that as the brake pads are moved in a direction opposite from the brake housings, the brake pads are forced into frictional contact with the guide rails. Eventually the brake pads become wedged between the guide rails and the brake housing such that there is no relative movement between the elevator car and the guide rails.

Limiting springs support the brake housings, which regulate the normal force applied against the rails, and thus regulate the frictional forces generated between the brake pads and the guide rails. The governor rope holds the brake pads so that the frictional force between the brake pads and the guide rails remain over a predetermined threshold until the system can be reset.

To reset the safety system, the brake housing (i.e., the elevator car) must be moved upward while the governor rope is simultaneously released from the clutch. This returns the brake pads to their original positions.

One disadvantage with this traditional safety system is that the installation of the sheaves, rope, and governor is very time consuming. Another disadvantage is the significant number of components that are required to effectively operate the system. The governor sheave assembly, governor rope, and tension sheave assembly are costly and take up a significant amount of space within the hoistway, pit, and machine room. Also, the operation of the governor rope and sheave assemblies generates a significant amount of noise, which is undesirable. Further, the high number of components and moving parts increases maintenance costs. These disadvantages have an even greater impact in modern high-speed elevators.

This invention is an improved safety system that is remotely resettable and eliminates dependency on the governor, rope, and tension devices to avoid the difficulties mentioned above.

SUMMARY OF THE INVENTION

In general terms, this invention is a brake system for an elevator that includes a stopping mechanism that responds to an electronic control signal to prevent movement of an elevator car within a hoistway under selected conditions. A speed sensor continuously monitors elevator speed. An elevator control generates the electronic control signal based on the elevator speed. The inventive safety system does not require a governor sheave, governor rope, or tension sheave. Further, the emergency stopping mechanism is selectively resettable from a remote location. Preferably, the stopping mechanism is utilized in an elevator safety system and comprises an emergency stopping mechanism.

In one disclosed embodiment, the emergency stopping mechanism includes safety wedges positioned on opposing sides of a guide rail. A safety housing is fixed for movement with the elevator car. The safety housing cooperates with the safety wedges to apply a braking force to the guide rail when the safety wedges are moved from a non-deployed position to a deployed position. A first latching device holds the safety wedges in the non-deployed position and a second latching device locks the safety wedges in the deployed position. Springs are associated with each of the safety wedges to move the safety wedges from the non-deployed position to the deployed position once the first latching device is released in response to the electronic control signal from a system actuator.

In another example, the emergency stopping mechanism utilizes a solenoid actuator to deploy the safety wedges. The solenoid actuator includes an electric motor, electromagnet, linear screw, and gear box. A carrier plate is connected to the springs with a connector member. The electromagnet holds the carrier plate, with the springs in a compressed condition, in place during non-deployed operation. When the safety system is activated, the electromagnet releases the carrier plate and the springs move the safety wedges into contact with the guide rail to stop the elevator car.

When the system receives a reset signal, the gear and motor work together to move the electromagnet into engagement with the carrier plate. The electromagnet is then energized to connect the carrier plate to the motor with sufficient force to compress the springs. The motor and gear box then pull the electromagnet and the carrier plate back into the non-deployed position with the springs being held in a compressed condition.

The subject safety system decreases the equipment costs and installation time. Further, the system requires less maintenance due to fewer cycles and wearing parts, and provides faster stops in high rise applications. The various features and advantages of this invention will become apparent to those skilled in the art from the following detailed description of the currently preferred embodiment. The drawings that accompany the detailed description can be briefly described as follows.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 schematically illustrates an elevator with an elevator safety mechanism incorporating the subject invention.

Figure 2 schematically illustrates one example of the elevator safety mechanism in a non-applied position.

Figure 3 schematically illustrates the elevator safety mechanism of Figure 2 in an applied position.

Figure 4 schematically illustrates the elevator safety mechanism of Figures 2 and 3 in a reset position.

Figure 5 schematically illustrates another example of an elevator safety mechanism incorporating the subject invention.

Figure 6 schematically illustrates the mechanism of Figure 5 in a ready to deploy position.

Figure 7 schematically illustrates the elevator safety mechanism of Figure 6 in a deployed position.

Figure 8 schematically illustrates the elevator safety mechanism of Figure 6 in a re-engagement position prior to system reset.

Figure 9 schematically illustrates the elevator safety mechanism of Figure 6 in a system recovery position occurring during system reset.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

An elevator assembly 2, shown in Figure 1, is mounted for movement within a hoistway 4. The elevator assembly 2 includes a speed sensor 6 that continuously measures the speed of the elevator assembly 2. The sensor 6 communicates with an elevator control 8, which generates control signals for controlling movement of the elevator assembly 2. Any type of speed sensor known in the art could be used to monitor elevator speed. The control 8 also communicates with an elevator brake system 10. The brake system 10 includes a unique configuration that can be incorporated into various different types of elevator brakes. In one example, the elevator brake system 10 comprises an elevator safety brake system that stops the elevator 2 from traveling at excessive speeds.

As seen in Figure 2, one example of the elevator safety brake system is shown generally at 10a. The elevator safety brake system 10a includes a safety housing 12 that is connected to an elevator car frame 14. Thus, movement of the safety housing 12 corresponds to movement of an elevator car 16. Safety wedges 18 are positioned on opposing sides of a guide rail 20 and are normally spaced apart from the guide rail 20 to allow free movement during normal elevator operation.

The control 8 includes an actuator 22a that moves the safety wedges 18 from a deployed or braking position, as shown in Figure 3, to a non-deployed or non-braking position as shown in Figure 2. Any type of known actuator 22a can be used to move the safety wedges 18. For example, the actuator 22a can comprise a linear actuator such as a screw drive or solenoid.

A spring 24 is associated with each safety wedge 18 to move the wedges 18 from the non-deployed to the deployed position. A first holding or latching device 26 holds the safety wedges 18 in the non-deployed position and a second holding or latching device 28 holds the safety wedges 18 in the deployed position. In one example, the first 26 and second 28 latching devices are solenoids, however, other holding or latching devices could also be used including mechanical and electrical devices.

As shown in Figure 2, the springs 24 are positioned under the safety wedges 18 in a compressed condition and are latched into place by the first latching device 26. Once the first latching device 26 is deployed (i.e., retracted from engagement with the spring ends), then the springs 24 extend upwardly to move the safety wedges 18 relative to the safety housing 12 and into engagement with the guide rail 20. The safety wedges 18 move upwardly until the safety wedges 18 are latched by the second latching device 28. This latching action can be powerlessly performed by using a spring (not shown) in the solenoid that biases an arm of the solenoid into the position shown in Figure 3.

As shown in Figure 3, once the safety wedges 18 are latched into place by the second latching device 28, the conventional normal force limiting springs shown schematically at 30, which support the safety housing 12, are compressed and the friction between the wedges 18 and the rail 20 remains essentially constant over a predetermined threshold value.

Once the elevator car 16 has stopped, the actuator 22a can be activated to reset the springs 24, as shown in Figure 4. A connector 32 interconnects the actuator 22a to each spring end 34. The connector 32 preferably comprises a steel shaft, however, other similar connectors such as a wire and tape, for example, could also be used.

While the safety wedges are waiting to be deployed, or during deployment, the connectors 32 preferably are disengaged from the actuator 22a so that the safety wedges 18 move without any resistant force from the connectors 32. Once the safety wedges 18 are latched by the second latching device 28, the connectors 32 should automatically engage the actuator 22a. When the spring 24 is being reset by the actuator 22a, once the spring 24 passes the first latching device 26, the connectors 32 preferably are automatically disengaged from the actuator 22a. These functional requirements can be satisfied by spring-latch based mechanisms or by using additional actuators.

Once the spring 24 is reset, the entire safety system 10 can be reset by first resetting the second latch device 28 and subsequently moving the safety housings 12 upwardly. Low-power actuators can be used as the preferred solenoid latching devices because they are used only for latching and the actuator 22a includes drive components that do not require fast actuator operation, because the recovery process from the stop can be performed slowly.

Another example of an elevator safety brake system is shown generally at 10b in Figure 5. This configuration utilizes the safety housing 12, wedges 18, springs 24, and connectors 32 as described above. This configuration further includes a solenoid actuation system 22b with a mounting plate 36, a clevis 38 for attachment of the plate 36 to the car frame 14 (Figure 1), an electric motor 40 mounted to the mounting plate 36, and a gear box 42 that is operably coupled to the motor 40. The gear box 42 drives a linear screw 44, such as a ball screw or jackscrew. The actuator 22b also includes an electromagnet 46 and a carrier plate 48 that is attached to the connectors 32. A nut 50 is received within the electromagnet 46 to engage the linear screw 44. The nut 50 is fixed for movement with the electromagnet 46. Wires 52 extend between the mounting plate 36 and electromagnet 46 and are operably connected to a power source (not shown) to selectively power the magnet 46. The system 10b also

includes at least two engagement sensors 54a, 54b to monitor movement of the electromagnet 46 and carrier plate 48, which will be discussed in greater detail below.

This configuration provides rapid actuation of the safety brake system 10b in a failsafe manner and provides resetting of the safety brake system 10b in a manner in which the safety wedges 18 are always ready for actuation. Resetting of the wedges 18 can be a slow operation, thus permitting the use of small and cost effective motors and gear boxes. The actuator 22b operates directly against the full actuation spring force of the safety wedges 18 to minimize the number of components and to reduce complexity of the system 10b.

The gear box 42 preferably includes planetary gearing for a narrow actuator package or worm gearing for a flatter and reduced cost system, however, other gear configurations could also be used.

Figures 6-9 show operation of the safety system 10b and actuator 22b from an initial non-deployed position to a system reset position. In Figure 6, the system 10b is in a ready state. The failsafe springs 24 are fully compressed and the electromagnet 46 is holding the spring 24 in position with the carrier plate 48. If there is a loss of power or if elevator car 16 (Figure 1) speed exceeds a predetermined threshold, the system 10b is activated.

As shown in Figure 7, the electromagnet 46 releases the carrier plate 48 and the springs 24 accelerate the safety wedges 18 into contact with the rail 20. This compresses the normal force limiting springs 30, resulting in constant friction between the wedges 18 and the rail 20 to hold the wedges 18 in the deployed or locked position. When an electronic reset signal is received, as shown in Figure 8, the motor 40 and gear box 42 are activated to drive the electromagnet 46 into contact with the carrier plate 48. The electromagnet 46 is energized to connect the carrier plate 48 to the actuator 22b such that the linear screw can compress the springs 24 to release the safety wedges 18. The connection is verified with one of the engagement sensors 54a.

During reset, as shown in Figure 9, the motor 40 and gear box 42 pull the electromagnet 46 and carrier 48 back into the ready state with the linear screw 44, compressing the springs 24. The other engagement sensor 52b indicates when the electromagnet 46 has returned to its initial, non-deployed position. At any time

during the reset operation, if the safety system 10b is required to be re-activated, the electromagnet 46 can release the carrier plate 48 to re-engage the wedges 18 against the rail 20.

It should be understood that the subject invention could be utilized with any known friction braking surface and friction brake members. Thus, the description of safety housings and wedges are merely an example of one type of friction braking surface and friction brake member that could benefit from the subject invention.

This unique system provides several advantages over traditional governor systems. There is lower cost because the traditional governor sheaves and ropes have been eliminated. Noise is also significantly reduced due to the elimination of the sheaves and rope. Maintenance and system costs and downtime are reduced because there are no wearing parts. Also, because the governor rope has been eliminated, there is no rope stretch, thus response time is consistent under all situations. Installation costs are also reduced because equipment no longer needs to be installed in the pit or in the machine room. Finally, the system requires less space in the hoistway which is an advantage for high speed elevator systems.

The preceding description is exemplary rather than limiting in nature. Variations and modifications to the disclosed examples may become apparent to those skilled in the art that do not necessarily depart from the essence of this invention. The scope of legal protection given to this invention can only be determined by studying the following claims.